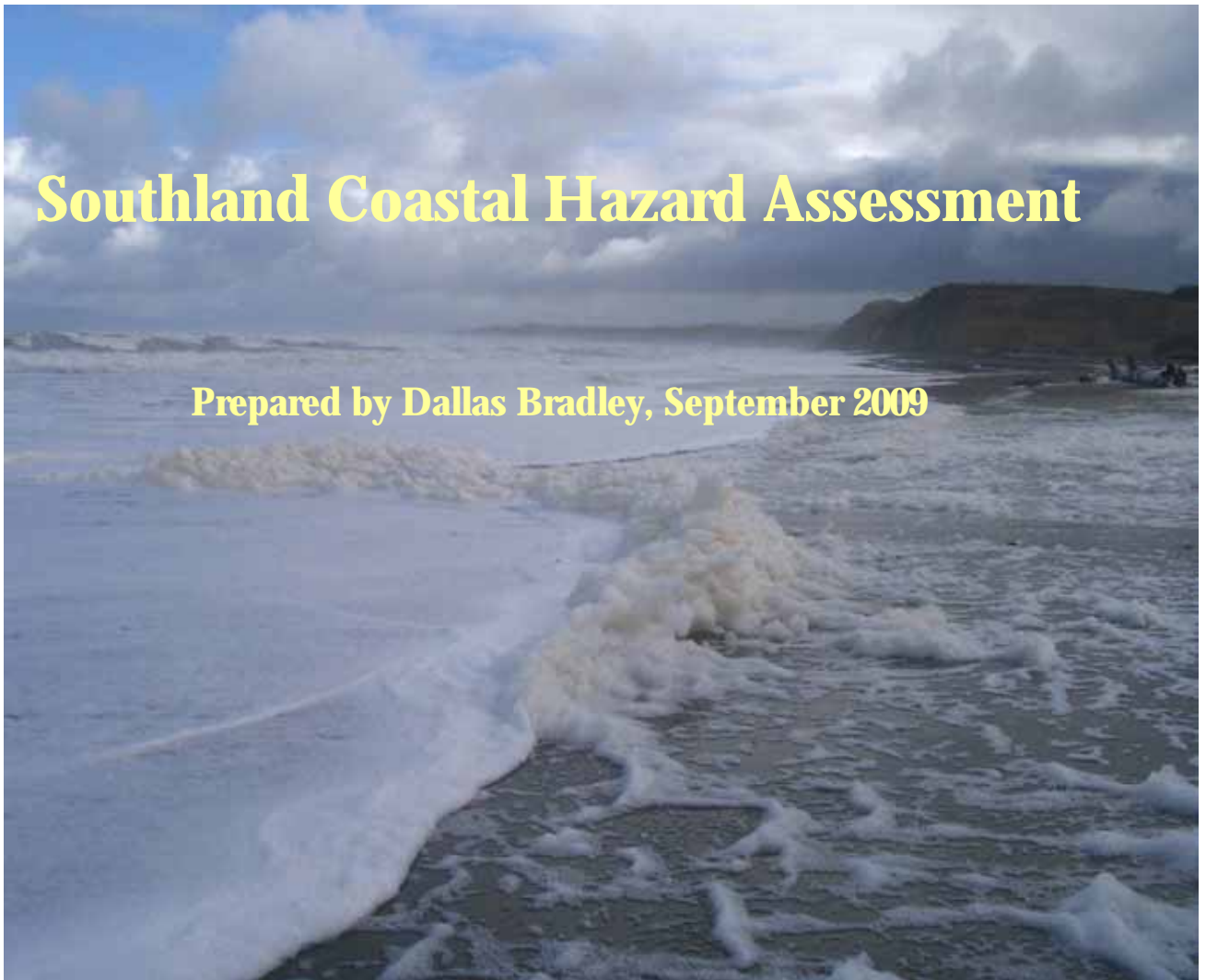




Southland Coastal Hazard Assessment

Prepared by Dallas Bradley, September 2009



Southland Coastal Hazard Assessment

1. Introduction

The Southland Coastal Hazard Assessment has been prepared to assist with resource management and engineering lifelines processes.

The principle purpose of the assessment is to flag the existence of particular hazards for further investigation, as and when necessary.

The assessment is more in the nature of a “once over lightly” examination, rather than an in-depth study of the natural hazards that affect the coast.

2. Scope

The assessment covers the mainland Southland open coast from the western end of Te Waewae Bay to the Otago/Southland boundary at Waiparau Head.

The assessment does not cover Stewart Island and only touches lightly on harbours and estuaries, the reason being that within the developed parts of Stewart Island (parts of Paterson Inlet, Halfmoon and Horseshoe Bays) and in mainland estuaries and harbours, there are numerous areas subject to coastal hazards, principally coastal erosion. As such, it is recommended that any development adjacent to the shores of any estuary or harbour is subject to a site specific natural hazard investigation. In many cases, the hazard will have already been addressed to a degree, usually by physical works, some dating back many years.

3. Hazards Investigated

The hazards specifically investigated are erosion/accretion, marine inundation and tsunami. The assessment also records the Land Resource Inventory Classification of the erosion potential of the land adjoining the coast.

Sea level rise has not been treated as a hazard in its own right, but as an exacerbator of erosion and marine inundation hazards.

The assessment is principally based on what has happened in the past. Predicted climate change and, more particularly, sea level rise are likely to accelerate or instigate more coastal erosion in the future.

Although estuaries and harbours were not rigorously assessed, coastal erosion is generally occurring in these areas as extensively as it is on the open coast.

The assessment tends to be dominated by the erosion hazard, mainly because it is extensive, long lasting, persistent and relative to other hazards, obvious. Hazards such as marine inundation and tsunami are episodic and generally less frequent.

Coastal erosion becoming an increasingly significant issue in some places, especially Colac Bay, and it is an issue to some degree almost everywhere.

As far as the tsunami hazard is concerned, the “Review of Tsunami Hazard and Risk in New Zealand” undertaken by Geological and Nuclear Sciences in January 2006 is the most authoritative source. Taking both local and distant sources into account the 100, 500 and 2500 return period wave heights above mean sea level are 0-2, 2-4 and 4-8 metres respectively for the area covered. Significant local variations could occur. The significant effects of historic tsunami have also been noted.

Two further reports, “Understanding local source tsunami: 1820’s Southland Tsunami” jointly published in November 2005 by GNS and NIWA and “Otago region hazards management investigation: tsunami modelling study” published in September 2007 by NIWA contain some additional information on the modelled behaviour in particular locations of tsunami generated from different sources. The former also includes the outcome of a search of historic documents that reported tsunamis in the 1800’s.

The marine inundation hazard as created by storm surge events is dependent on the land height and the wave and sea level regime within or along any coastal reach. Land heights are not generally well known but as a general rule one should be wary of land below 3.5 and 6.0 metres above mean sea level adjoining harbours/estuaries and the open coast respectively.

4. Format of the Assessment

The main part of the assessment consists of an excel spreadsheet that describes various sections of coastline and the hazards contained within. That is followed by a collection of photographs and plans that illustrate the hazards referred to.

5. Use of the Assessment

The assessment should be used to identify areas or infra-structure that may be vulnerable to the occurrence of the natural hazards discussed, then implement an appropriate management regime that is underpinned by concepts of sustainability and resilience.

As far as Local Authorities are concerned, such decisions should be guided by Coastal Hazards and Climate Change – A Guidance Manual for Local Government in New Zealand published by the Ministry for the Environment in July 2008.

Coastline Reach	Upper Beach/ Coast type	Land Behind	Notable Features	Engineering Lifelines	Hazards					Comments	References
					Coastal Erosion	Coastal Accretion	*Hinterland Instability	Marine Inundation	Tsunami		
Te Waewae Bay (Track Burn to Waikoau River)	Sandy	Flat forested bench initially then rising.	Cribs on flat land above MHWMS at Waikoau Mouth	Logging access road along land immediately above beach. Relatively new Swing Bridge (walking) at Waikoau Mouth - previous bridge (road) washed out by riverine flooding	Yes, western two thirds (1950 -1981)	west of Waikoau mouth decreasing towards west	Slight Slipping/ Slumping	probable	Probable, especially at river mouths ² - see attached wave height/ probability maps - extract from p96-98 of GNS report	Net westward longshore sediment transport. ¹ "the longshore drift direction varies with wave regime, although in the long term may be more generally to the south east." ¹⁶ Significant change around Waikoau Mouth (accretion on west side, erosion on east - see plot of past coastline positions) See Fig.1.	1. Kirk R.M. & Shulmeister Dr J. (1994): "Geomorphic processes and Coastal Change in the Lagoon System, Lower Waiau River, Southland." Report to the Waiau River Working Party convened by the Southland Regional Council, May 1994." 2. Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd. 4. URS (2008) Manapouri Tailrace Amended Discharge Project (MTAD): Geomorphology Assessment.
Te Waewae Bay (Waikoau River to Rowallan Burn)	Boulders transitionin g from west to gravel then sand	Western half steep, eastern half narrow flat bench with steep land/terrace above	Hump Track walk begins about half way along this reach.	Road on bench above beach was eroded in 2007 (See Figs 2a & 2b)to the point where it was replaced in 2009 by a new inland road.	Active erosion post 1981 See Fig 2	substantial accretion 1947 -1981 See Fig 2	Negligible erosion	definitely, debris on road from time to time	Ditto	Net westward longshore sediment transport. ¹ "the longshore drift direction varies with wave regime, although in the long term may be more generally to the south east." ¹⁶	2. Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd.
Te Waewae Bay (Rowallan Burn - Waiau Mouth)	Sandy from Rowallan to Groveburn, gravelly from Groveburn to Waiau	Cliffs or steep from the Rowallan Burn to Grove Burn, wide bench backed by cliffs from the Grove Burn to Waiau Mouth. Degrading gullies in and behind - land has an uplifted appearance.			Active erosion post 1981. See Fig 3	Generally accretion 1947 -1981. See Fig 3	Slight Wind Erosion	probable but at present tends to be confined to southern margin of bench.	Ditto	There used to be a road at the top of the beach along the western part but it has been completely eroded away. Net westward longshore sediment transport. ¹ "the longshore drift direction varies with wave regime, although in the long term may be more	3. NZAM Aerial Photograph Runs 1247 - 1253 (1947), Environment Southland Aerial Photo Runs A0423 & A2182. 15. Halliday Consulting, August 2004. Stability of Proposed Building Sites at Croymans Subdivision, Papatotara;

Coastline Reach	Upper Beach/ Coast type	Land Behind	Notable Features	Engineering Lifelines	Hazards					Comments	References
					Coastal Erosion	Coastal Accretion	*Hinterland Instability	Marine Inundation	Tsunami		
										generally to the south east." ¹⁶	
Te Waewae Bay (Waiau Mouth and barrier beach)	Gravelly	Cliffs above the western and eastern end of the Lagoon created by the barrier beach. Cliffs at west end of lagoon and west of the cribs are slipping.	Cribs above western cliffs (See Fig 4b), a few, (but reducing number) of cribs on floodplain to east of Waiau River	Former Bluecliffs Beach Road has been eroded away between Waimotu and Cameron Creeks	Active erosion, particularly at the western end.	No	Slight Wind Erosion	Yes	Ditto	A very dynamic area subject to mouth closures and mouth movements over 4km of the 6km barrier length. Coastal processes dominate over riverine processes. ¹ Mouth appears to be moving westward but that may change. Bench below western cribs is currently eroding and barrier beach appears to be moving inland over western most 2km. The lagoon itself has extended westwards by about 300 metres since 1981. See Figs 4 & 4a.	5. Turnbull I.M. & Allibone A.H. (Compilers) "Geology of the Murihiku Area (2003)" Institute of Geological & Nuclear Sciences.
Te Waewae Bay (Waiau Mouth - Waimeamea Stream)	Gravelly	Cliffs or steep slopes above a narrow bench. Past slipping/slumping of slopes between McCracken's Rest and Grindstone	McCracken's Rest,	SH99 in close proximity to top of cliffs or steep slopes	Active erosion along full length (See Figs 6 & 7)	No	Slight Slumping and Wind Erosion	No	Ditto	It appears that the Te Waewae Bay coast east of the Waiau is under supplied with sediments and is consequentially erosional. ¹ "the longshore drift direction varies with wave regime, although in the long term may be more generally to the south east." ¹⁶ Pattern of erosion could change over time as bench erodes to the point where erosion attacks the bottom of cliffs. Coastal processes dominate.	

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		Creek (See photo Fig 5)									
Waimeamea Stream - Gemstone Beach (Taunoa Stream)	Gravelly	Cliffs immediately above high water mark	Gemstone Beach	Road end at Gemstone Beach	MHWMS at toe of cliffs - probably eroding but difficult to measure from photos. Cliffs are slumping.	No	Slight Slumping and Wind Erosion	No	Ditto	It appears that the Te Waewae Bay coast east of the Waiau is under supplied with sediments and is consequentially erosional. ¹	
Te Waewae Bay [Gemstone Beach (Taunoa Stream) to Monkey Island]	Sand gravel mix at west end with a transition to sandy at the east end	Cliffs immediately above high water mark between Gemstone Beach and Falls Creek are slumping in places (See Figs 8 & 8a). Cliffs are above a narrow bench for the most part. Further east the cliffs reduce to banks towards Monkey	Orepuki and Monkey Island	Road end at Orepuki (Falls Creek)	Active erosion from Gemstone Beach to Falls Ck from 1947 - 1981 & 1981 - present. Minor erosion at Monkey island end of beach.	Some accretion between Falls Creek and Kaitangata Point between 1981 & present	Moderate Wind erosion	Not generally an issue	Ditto. There is also a historic reference to a "tidal wave" that overwhelmed a "tribe" walking along this beach in the 1800's.	It appears that the Te Waewae Bay coast east of the Waiau is under supplied with sediments and is consequentially erosional. ¹ Pattern of erosion could change over time as bench erodes to the point where erosion attacks the bottom of cliffs.	6. Bradley, D. 2002 "Tsunami - Invercargill City Lifelines Hazard Report, Section 5, pages 1-13". Invercargill City Council.

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					Coastal Erosion	Coastal Accretion	*Hinterland Instability	Marine Inundation	Tsunami		
		Island.									
Te Waewae Bay (Monkey Island - Pahia Point	Rocky with occasional gravelly pocket beach	Marine terrace (6-10 metres) gently rising farmland on Marine bench above.	Cemetery & Takitimu Estate subdivision east of Monkey Island.	Frentz Road and associated power and telephone lines.	Minor	No	Slight Wind Erosion	No	No	Northern aspect	7. DTec Consulting Ltd (Sept 2004) Coastal Erosion Assessment: Proposed Takitimu Estates Ltd Subdivision; Te Waewae Bay, Southland.
Pahia Point - Wakapatu Point	Rocky with occasional gravelly pocket beach	Rocky/rising farmland	Cosy Nook	Slipways at Cosy Nook and Garden Bay. Small part of Garden Road.	Minor	No	Slight to moderate wind erosion	No	Yes	Western aspect	8. DTec Consulting Ltd (April 2007) Coastal Hazard Assessment: Proposed Pahia Farm Subdivision, Ruahine Hill, Southland.
Wakapatu Point - Trig Kawakaputa	Steep cliffs to rocky with occasional pocket beach at east end	Rocky/rising farmland		One seldom used private slipway.	Minor	No	Slight to moderate wind erosion	No	No	South eastern aspect	
Kawakaputa Bay (Wakapatu Beach) Trig Kawakaputa - Pouahiri Creek	Sandy	fairly flat	Beach access tracks		Yes, significant - See Fig 9	No	Slight to moderate wind erosion	likely	Yes	Figure ?? East - south east aspect	9. Rennie, H (1980) "Recent Shoreline Trends of Southland Beaches - Oreti Beach, Colac Bay Beach, Kawakaputa Bay Beach. 3. NZAM Aerial Photograph Runs 1247 - 1253 (1947). 16. Environment Southland

Coastline Reach	Upper Beach/ Coast type	Land Behind	Notable Features	Engineering Lifelines	Hazards					Comments	References
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											Aerial Photo Runs A0408 & A2182.
Kawakaputa Bay (Wakapatu Beach) Pouahiri Creek - Ourawera Stream	Sandy becoming more gravelly to east	fairly flat	Beach access track		No	Yes - See Fig 10	moderate wind erosion	likely	Yes	south east aspect. Ourawera Stream mouth a popular whitebaiting spot. Stream often straightened at mouth (ES Resource Consent W264-001).	9. Rennie, H (1980) "Recent Shoreline Trends of Southland Beaches - Oreti Beach, Colac Bay Beach, Kawakaputa Bay Beach
Kawakaputa Bay (Wakapatu Beach) Ourawera Stream - Eastern end of gravelly beach)	gravelly, often wide back beach	significant dune system			No	Yes - See Fig 11	moderate wind erosion	No	No	South - south west aspect. Large back beach area being slowly vegetated. Vegetation line is indistinct in places.	9. Rennie, H (1980) "Recent Shoreline Trends of Southland Beaches - Oreti Beach, Colac Bay Beach, Kawakaputa Bay Beach
Eastern end of Wakapatu Beach to Oraka Point	Rocky with occasional gravelly pocket beach	rising farmland marked with rocky outcrops	Urupa at Oraka Point		DCDB overlay suggests that there has been some erosion at beaches.	No	Slight wind erosion	No	No	South - south west aspect.	
Oraka Point - South end of Colac Foreshore Road	Generally rocky	rising farmland marked with rocky outcrops			Generally not significant	No	Slight wind erosion	Generally not	Generally not	Eastern aspect	

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South end of Colac Foreshore Road - Huraki Creek	Rocky foreshore with gravelly upper beach	some lowlying but generally marine terrace and rising land.	Boat Ramp	Boat Ramp, Colac Foreshore Road, Coastal Rock protection works	Yes, north of boat ramp. Rock Protection placed in several locations to protect the road from erosion.	Some south of boat ramp	Slight wind erosion	Yes between foot of terrace and shoreline.	Yes ^{2,6} between foot of terrace and shoreline.	North East aspect. Intermittent Rock protection to protect erosion hot spots at roadside.	10. Tonkin & Taylor Ltd, (December 1997) "Colac Bay Foreshore Protection" 11. DTec Consulting Ltd (July 2005) Coastal Hazards Assessment for Colac Bay Ltd"
Huraki Creek - "Tihaka Sands" at the east end of Colac Foreshore Road	Sandy foreshore below rock protection works	flat - slowly rising. Approximately 5m amsl	Colac Bay township, Urupa, Marae and restaurant (See Figure X ST oblique aerial photo)	Colac Foreshore Road, power & telephone, Rock coastal protection works - See Figs 12, 13, 14 & 15.	Yes - coastal protection works in place for much of the reach but these are subject to overtopping and scouring in storms. Unprotected section is subject to active erosion.	No, hinge point between erosion and accretion is located in the vicinity of the east end of this reach ¹²	Slight wind erosion	Yes but not extensive to date See Fig 13	Yes ^{2,6} 1960 tsunami put debris on the Foreshore Road.	East to south east aspect but vulnerable to erosion/inundation in south - south west storms.	2. Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd. 6. Bradley, D. 2002 "Tsunami - Invercargill City Lifelines Hazard Report, Section 5, pages 1-13". Invercargill City Council. 10. Tonkin & Taylor Ltd, (December 1997) "Colac Bay Foreshore Protection"
"Tihaka Sands" to east end of Tihaka Beach, Colac Bay	Gravel - gravel increases in easterly direction along beach	Active/old dunes	Tihaka Sands subdivision	Tihaka Beach Road (vulnerable)	Generally No	Slight in places, most apparent at east end. General consolidation of near shore vegetation since 1981	Slight wind erosion	Potentially, but not extensive - most susceptible at eastern end.	Potentially ²	Southerly aspect	9. Rennie, H (1980) "Recent Shoreline Trends of Southland Beaches - Oreti Beach, Colac Bay Beach, Kawakaputa Bay Beach. 14. DTec Consulting Ltd (October 2004) Coastal Hazards Assessment: Tihaka Sands Proposed Subdivision, Colac Bay, Southland"

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East end of Tihaka Beach to Howells Point.	Many coarse sand/gravelly beaches separated by frequent rocky headlands.	Generally marine terrace (6-10metres) with gently rising farmland on marine bench above. Low dunes towards east end.		Nil	Generally no, apart from areas backed by dunes. Dunes are increasingly stable.	Not apparent	Generally slight wind erosion but moderate in dune areas.	Not generally an issue	Slight ²	South - south west aspect. Hazards not generally an issue due to type of existing development.	
Howells Point - Aparima Mouth	Rocky headlands with indispersed pocket beaches (gravel and sand) giving way to sandy beach (Taramea Bay) at east end.	Mixture of dune, marine terrace and low marine platform (Taramea Bay)	Taramea Bay Soundshell	Rocks Highway and associated infrastructure including a gabion structure at one point.	No	No	Negligible	Yes in reserve behind Taramea Bay	Significant in Taramea Bay ^{2,6,12} (See map, Figure ?)	Generally east to north east aspect but swells diffract significantly around Howells Point and into Taramea Bay. Riverton ground levels are generally 323mm higher than the mean level of the sea (2005) than ground levels in terms of mean sea level (Riverton BM's) would indicate.	6. Bradley, D. 2002 "Tsunami - Invercargill City Lifelines Hazard Report, Section 5, pages 1-13". Invercargill City Council. 12. Western Star 12 May 1877. 13. Environment Southland temporary tide gauge connection to Bench Marks 1 and 5.
Jacobs River Estuary	Generally estuarine	Generally rolling farmland or part of urban Riverton		Wharves, road bridge, some adjoining roads	Yes, particularly on the east side of the upper estuary and downstream of bridge on the nith side where ongoing erosion threatens an urupa. See Fig 16. Some existing erosion protection work in places.		Generally negligible erosion risk.	Potentially, but not extensive - most susceptible at eastern end.	Yes ^{2,6,12} Records recall the 1868 and 1877 tsunamis affecting the harbour	Riverton Township - The town has a network of bench marks that first levelled by Duffil Watts & King for the Wallace County in terms of an assumed datum. These bench mark heights have been adjusted by Don Moir, Reg'd Surveyor for SDC, and ES to heights in terms of mean sea level using Riverton Trig (120.73m) as an origin of levels). A connection between these bench marks and the mean level	12. Western Star 12 May 1877. "...a succession of no less than seven tidal waves rolled into the Riverton Harbour between 7 and 12 o'clock yesterday. About 9 o'clock a wave, between three and four feet high, rolled up the river ..."

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					Coastal Erosion	Coastal Accretion	*Hinterland Instability	Marine Inundation	Tsunami		
										of the sea established from a temporary tide gauge erected by ES in July 2005 indicates that the bench marks are actually a further 323 millimetres above the mean level of the sea (2005) than the heights based on Riverton Trig would suggest.	
Jacobs River Estuary to Steep Head	Sandy beach backed by marram covered dunes of varying height and depth.	Fairly flat farmland (west of Ferry Road) & gravel pits/recreational areas (east of Ferry Road).	Popular recreational beach (Oreti Beach), Curranstown	Two road ends providing access to the beach	Historically yes but marram planting has resulted in general accretion overall. However, erosive phases occur from time to time..	Yes for the majority of this reach.	Slight to moderate wind erosion.	An issue around creek mouths	Potentially but few assets at risk. Historic records recall the 1868 tsunami affecting people travelling on the beach between Riverton and Invercargill, especially at the Waimatuku Mouth.	Exposed to prevailing west and south west winds	15. Hazards Report, Invercargill City Lifelines Project, 2001 2. Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd.
New River Estuary	Large estuary containing the mouths of the Oreti and Waihopai Rivers - a wide range of shoreline types					Slight wind erosion				The Hazards within and around the New River Estuary were addressed in the Invercargill City Council Engineering Lifelines Project Hazard Report ¹⁵ in Aug 2001. Since then the following relevant reports have been prepared: DTec Consulting Ltd (June 2007) Coastal Erosion Study: Omaui, Southland ¹⁸ ES submission on the ICC Otatara Issues and Options paper, May 2009 for comment on natural hazards around the Otatara area ¹⁹ .	

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										Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd.	
Steep Head to Stirling Point	Generally rocky coastline with occasional pocket beaches	Rolling to steep farmland or reserve	A scenic, exposed coastline with little development. Former Ocean Beach freezing works.	Bluff Sewage Outfall	Yes on soft shores		Slight wind or sheet erosion.	No	No Significant effects		
Bluff Harbour	Large Harbour containing the Port of Bluff								Yes, Bluff Township, Port and possibly the NZAS site ²	The Hazards around Bluff Harbour, more particularly the Bluff Township, are addressed in the Invercargill City Council Engineering Lifelines Project Hazard Report ¹⁵ The level of the Island Harbour at the Port of Bluff is 3.27m amsl.	15. Hazards Report, Invercargill City Lifelines Project, 2001 2. Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd.
Tiwai Point to Fortrose	Generally steep coarse sand or gravel beaches	Generally gravel ridges or spits separating internal water bodies from the sea. Mostly DoC estate apart from land immediately around the NZAS	Aluminium Smelter	Navigation Aids [Rear Leading Light No 1 & Bushy Point light (See Figs 17a, 17b & 17c)], NZAS Outfall structure	General erosion, (significant around Bushy Pt) from Trig Q to the east end of Lake Waituna. See Figs 17d & 17e.	Historic accretion from Tiwai Point to Trig Q but currently eroding.	Moderate wind erosion on Toetoes spit, slight wind erosion elsewhere.	Potentially but few assets at risk	The standard floor height for NZAS buildings is 4.57m amsl (15 feet amsl) Pers.comment, Kevin Duke NZAS.		

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		Aluminium Smelter									
Toetoes Estuary	Sandy or muddy shores	Wetland or farmland	Fortrose Township	Moray Terrace and Boat Harbour Road, Tokanui Gorge Road Highway, Boat Ramp,	Significant ongoing erosion between Lewis and Darien Streets (See Figs 18,18a &18b) .	No		Potentially an issue along Moray Terrace	Potentially an issue along Moray Terrace and the Tokanui Gorge Road Highway ² .	2. Berryman K (2005) "Review of Tsunami Hazard and Risk in NZ" Institute of geological and Nuclear Sciences Ltd. Survey Plan SO 4856 that shows the position of the coast in relation to section boundaries at the time of the initial survey (See Fig 17b).	
Fortrose to Waipapa Point	Variable - sandy/gravelly beaches and rocky platforms	rolling farmland	Waipapa Point lighthouse, Boat ramp at Boat Harbour Beach Frasers Beach	Waipapa Lighthouse	Eroding along Boat Harbour Beach	Historic accretion along Boat Harbour Beach, South end of Frasers Beach,	Generally slight to moderate wind erosion	No	No Significant effects likely. Historic reference to "a huge tidal wave" in "From Waste Land to Wealth", a history of Otago written by Joan McIntosh. Bigger waves than usual reported during the 1960 tsunami.	A fairly remote section of coast along which there is little development. Historical, some quite recent, sand dune migration across farmland.	

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Waipapa Point to Mouth of Waipapa Stream	Sandy	Dunes, in some cases above low cliffs/banks	"Tararua" wreck and cemetery	Nil	Significant erosion (100 metres plus in places) from Waipapa Point to just west of Lake Brunton (See Fig 19)	Beach generally aggrading east of Lake Brunton but still not as seaward as the original surveyed position.	Generally severe wind erosion.		No Significant effects	A fairly remote section of coast along which there is little development.	
Mouth of Waipapa Stream to mouth of the Haldane Estuary/ Waipohatu	Mostly rocky, with rocky headlands and sheer rock cliffs. Large sand dune east of the mouth of the Waipapa Stream, and two small sandy beaches west of Slope Point (near Black Point).	Sandy dune country at Waipapa Stream end, isolated pockets of lowland indigenous vegetation with predominantly agricultural farm land at the Slope Point end.	1). There is a small marine beacon (blinker light) at Slope Point. 2). Slope Point is the southern most point in the South Island of NZ, and is becoming an increasingly popular tourism site. 3). Slope Point settlement (i.e. historical hamlet), situated approximately 1km inland of Slope Point.	Slope Point Road (and small part of Weir and School Roads) and associated power and phone facilities. Small marine beacon (blinker light) at Slope Point. Portion of the Slope Point Road west of Slope Point is situated at the top of high cliffs and eventually turns to dirt track past Black Point on towards the Waipapa Stream.	No	No	Moderate wind erosion at west end but generally slight wind or sheet erosion elsewhere.	No	No	A remote section of coast along which there is little development.	
Haldane Estuary/ Waipohatu	Estuarine and tidal mudflats, with margins including pasture, some	Estuary predominantly adjoins agricultural farmland. Isolated stands of indigenous	Weirs Beach camping ground, situated on the true right (west) side of the Haldane Estuary.	Weir Road, Haldane Curio Bay Road and Watson Road and associated power and phone facilities. A portion of the	Not assessed, but probable	No	Generally negligible erosion risk.	Yes	Yes ²	Tidal flooding on portion of the Haldane Curio Bay Rd (NNE side of the Haldane Estuary) is probably the key issue.	

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	vegetation and sand hills	vegetation near the outlet of the Haldane/Waipohatu River and Watson Road.		Haldane Curio Bay Rd (NNE side of the Haldane Estuary) is vulnerable to tidal flooding, usually at the top of spring tides. School Road is a dry weather road only.							
Mouth of the Haldane Estuary/ Waipohatu to Petrified Forest Bay	Haldane Bay is long and sandy, and has a reservoir (thought to be artificially/human made), with sand dunes in behind. East end has sheer rock cliffs/rocky headlands, small bays and the flat rocky platform of the Curio Bay Petrified Forest in the east.	Sandy dune country at the Haldane Bay end, with predominantly agricultural farm land above the high cliffs at the Mair Road end, along to the Curio Bay recreation reserve.	1). There is a large sand dune/sand spit east of the mouth of the Haldane Estuary. 2). There is a small manmade reservoir/lake situated behind (north) Haldane Bay. 3). Large sand dune across the west end of Mair Road (in the vicinity of Blue Cod Bay, at about Grid Reference 2209390E & 5386351N	Mair Road, and associated power and telephone facilities	Haldane Bay has generally eroded. Spit has got smaller and moved inland.	No	Moderate wind erosion for dunes above Haldane Bay. Slight wind and sheet elsewhere.	No	Low potential ²		

Coastline Reach	Upper Beach/ Coast type	Land Behind	Notable Features	Engineering Lifelines	Hazards					Comments	References
					Coastal Erosion	Coastal Accretion	*Hinterland Instability	Marine Inundation	Tsunami		
Petrified Forest Bay to a point opposite the Waikawa-Curio Bay Rd/Haldane-Curio Bay Rd intersection	<p>Rock ledges/large flat shelf, then guts, boulders and a rocky elevated headland at the Curio Bay end. Porpoise Bay is a large sandy bay, begins north of the rocky headland and extends around to the mouth of the Waikawa River.</p> <p>There is a large sand dune at the south end of Porpoise Bay, decreasing towards houses and increasing again north of Cooks Creek, around to</p>	Generally flat, and consisting of pasture, reserve, housing and indigenous vegetation (flax and lowland bush)	<p>1). Subdivision and land use proposal at 531 Waikawa Curio Bay Road, South Catlins, Southland, by Porpoise Bay Ltd, granted by way of EC consent order dated 15 Dec 2005 (16 lots).</p> <p>2). Curio Bay petrified forest, including yellow-eyed penguin viewing area, DOC structures and car park.</p> <p>3). Existing Porpoise Bay/Curio Bay settlement/holiday accommodation facilities</p> <p>4). Curio Bay/Porpoise Bay recreation reserve (camping ground), administered by the SDC, has facilities, a shop, parking areas, showers, camping areas and interpretation panels. Area is popular for a range of</p>	Niagara Waikawa Road, Waikawa Curio Bay Road, Haldane Curio Bay Road, Mair Road. Includes associated power and phone facilities.	South end of Porpoise Bay ¹⁹ , Cook Creek Mouth (See Fig 19).	No	Negligible to slight wind and sheet erosion	No	Low potential ²	Historical position of Cooks Creek in different position to current position, and the movement of this creek is a significant hazards issue. Rocks/sea wall protection area adjacent to Carla Brockmans crib (Sec 32 Blk VIII Waikawa Survey District) has experienced some damage.	17. Todd, Derek (DTec Consulting Ltd). February 2004. Coastal Hazards Assessment: Southern Porpoise Bay (report commissioned by Porpoise Bay Ltd for a proposed subdivision development at 531 Waikawa Curio Bay Rd, South Catlins, Southland). Figs 20 (Sketch Plan illustrating levels of land in the vicinity of Cooks Creek mouth, dated February 1968 (ES Level's Book 158) & Fig 20a

Coastline Reach	Upper Beach/ Coast type	Land Behind	Notable Features	Engineering Lifelines	Hazards					Comments	References
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	the Waikawa River mouth.		recreational/tourism and community activities, including fishing and boating, beach walking, horse riding, walking the Petrified Forest, vi								
A point opposite the Waikawa-Curio Bay Rd/Haldane-Curio Bay Rd intersection to the mouth of the Waikawa River	Porpoise Bay is large and sandy, with a large sandy dune behind.	Large sandy dune, flat land (sandy soil), backing onto bare agricultural land and the Waikawa Curio Bay Road.	Cultural/archaeological sites have been unearthed at the Waikawa spit site over at least the last 50 years (Aaron Leith, pers comm).	Niagara Waikawa Road, Waikawa Curio Bay Road, Haldane Curio Bay Road. Includes associated power and phone facilities.	East end of Porpoise Bay	Some historic accretion but probably eroding currently.	Slight Wind erosion	No	Low potential ²	The sand dunes at the Waikawa Spit are particularly unstable.	Waikawa Harbour Survey Plan SO461, which shows the harbour, channel and sandhills in 1864.

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Waikawa Estuary	Estuarine and tidal mudflats, with margins including pasture, some indigenous vegetation and sand hills below the jetties.	Estuary predominantly adjoins agricultural farmland, with isolated stands of indigenous vegetation and the Township of Waikawa.	1). Old Coach Road (historical, but parts still visible) on the true right side of the Waikawa Estuary, from the Waikawa Jetty to the mouth of the Waikawa River. 2). Cemetery/urupa at the top of the Waikawa Estuary (west side) adjacent to the Niagara Waikawa Road. 3). Extensive sites/cultural values along the estuary, both Maori and early European (Success Whaling Station was located at Trypot Bay, inside the entrance of the Waikawa Harbour in the 1830/40's.).	1). Two wharves adjacent to the estuary, to service the small commercial / recreational fishing fleet. A slipway to services the fishing fleet, and moorings. 2). Power and telephone along both sides of the Waikawa Estuary. 3). Some rock protection works along Antrim Street (wharf end). 4). Antrim Street, Niagara Waikawa Road, Waikawa Curio Bay Road, Manse Road, Gourley Road, Bell Road, Yorke Road, Falkner Road. 5). Fire Fighting facility in Waikawa township (605 Niagara Waikawa Road).	Probable but not assessed	No	Generally slight sheet erosion	1). A portion of Antrim Street (NNW of where it intersects with Mena Street) was subject to tidal flooding in the 1970's/1980's, Aaron Leith pers comm. 2). The tidal influence of the Waikawa River extends to the Niagara Bridge (main falls), and during spring tides, approx 1km upstream of that to the next upstream set of falls.	Yes, in low-lying areas	The lower portion of the channel of the Waikawa River below Wallace Point (149 Waikawa Curio Bay Rd) to Trypot Bay (inside the entrance of the mouth of the Waikawa Estuary) changed course significantly during a period in the 1980's-1990's. The channel is currently situated significantly closer to the true left (east) bank, than it was during the early 1980's (Aaron Leith, pers comm). The South eastern end of Antrim St is reclaimed from the former estuary (See SO 461).	Waikawa Harbour Survey Plan SO461, which shows the harbour, channel and sandhills in 1864 (See Fig 21)
Mouth of the Waikawa River to Waiparau Head	Mostly rocky, with rocky headlands, sheer rock cliffs. Four	Predominantly adjoins agricultural farmland, with isolated stands of	1). No permanent dwellings (other than temporary holiday crib at Dummy's Beach). 2). Dummy's	Progress Valley Road, Brothers Road and Faulkner Road, are gravel and are generally "dry	Dummys and Long Beach are eroding	No	Slight sheet erosion	No	No	A remote section of coast along which there is little development.	

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	sandy beaches at the eastern (Waiparau) end-Little Beach/Shades Beach (Te Ahi Mate), Dummys Beach and Long Beach the largest at approx 1km long. Significant sand dune system at Long Beach.	indigenous vegetation, some significant.	Beach is becoming an increasingly popular freedom camping/recreation destination during summer months. 3). Brothers Point rock (turimokomoko) and the Sisters are prominent offshore landmarks along this stretch of the coast.	weather only" roads. Various other vehicle "tracks" along this stretch of coast (some on private land), used for agriculture and public access/recreation.							

*Based on the Land Resource Inventory Classification as determined by the LRI 1:63660 mapping undertaken by the DSIR Soil Bureau in 1968

FIGURES





Figure 2a Papatotara Coast Road west of the Rowallan Burn, 17 May 2007 (Southland Times Photo)



Figure 2b Papatotara Coast Road west of the Rowallan Burn, 19 May 2007



Figure 3



Figure 4 Position of the West Waiou Lagoon as of 9 February 1981 overlaid on a 22 February 2003 photograph.



Figure 5 Cribs on terrace above the Waiau River mouth (west bank) 4 February 2009



Figure 5a Waiau River Lagoon east of the Waiau River mouth 4 February 2009



Figure 6 Coastline positions as of 1947 & 9 February 1981 overlaid on a 22 February 2003 photograph.



Te Waewae Shoreline - West of Grindstone Creek
19 November 1980

Figure 7



Figure 8 Coastline positions as of 1947 & 9 February 1981 overlaid on a 22 February 2003 photograph.



Figure 8a Cliff Slumping west of Dudley St, Orepuki, 9 September 2006



Figure 8b Cliff slumping on the south side Kaitangata Point, March 2007



Figure 9 Coastline positions as of 1950 & 9 February 1981 overlaid on a 22 February 2003 photograph.



Figure 10 Coastline positions as of 1950 & 9 February 1981 overlaid on a 22 February 2003 photograph (Pouahiri Stream on left, Ourawera Stream on right).



Figure 11 Coastline positions as of 1950 & 9 February 1981 overlaid on a 22 February 2003 photograph of the south east end of Kawakaputa Bay.



Figure 12 Colac Bay 11 January 2003. Southland Times photograph



Figure 13 Marine Inundation, Colac Bay, Date 16 April 1999 (Southland Times photo)



Figure 14 Damaged rock protection, Colac Bay - Photo: Bruce Halligan



Figure 14a Damaged rock protection, Colac Bay - Photo: Bruce Halligan



Fig 15 Rock protection under repair - 17 December 2008



Fig 15a Rock protection awaiting repair - 17 December 2008



Figure 16 Riverton (Jacobs River) Estuary – Partial comparison of 1950 coastline with that of 2008



Figure 17a Bluff Harbour Leading Light, Tiwai Point



Figures 17b & 17c Bushy Point Light between Tiwai Point and Lake Waituna



Figures 17d & 17e Large steel pipe on foreshore in Sept 2000 and May 2009 respectively.



Figure 18 Fortrose – Comparison of cadastral boundaries with the 2008 coastline position.



Figure 18a Recent erosion at Fortrose



Figure 18b 1877 survey plan showing the mean high water mark as the western boundary of Moray Terrace. (Compare with Fig 17)



Figure 19 Waipapa Point – Comparison of cadastral boundaries with the 2008 coastline position.

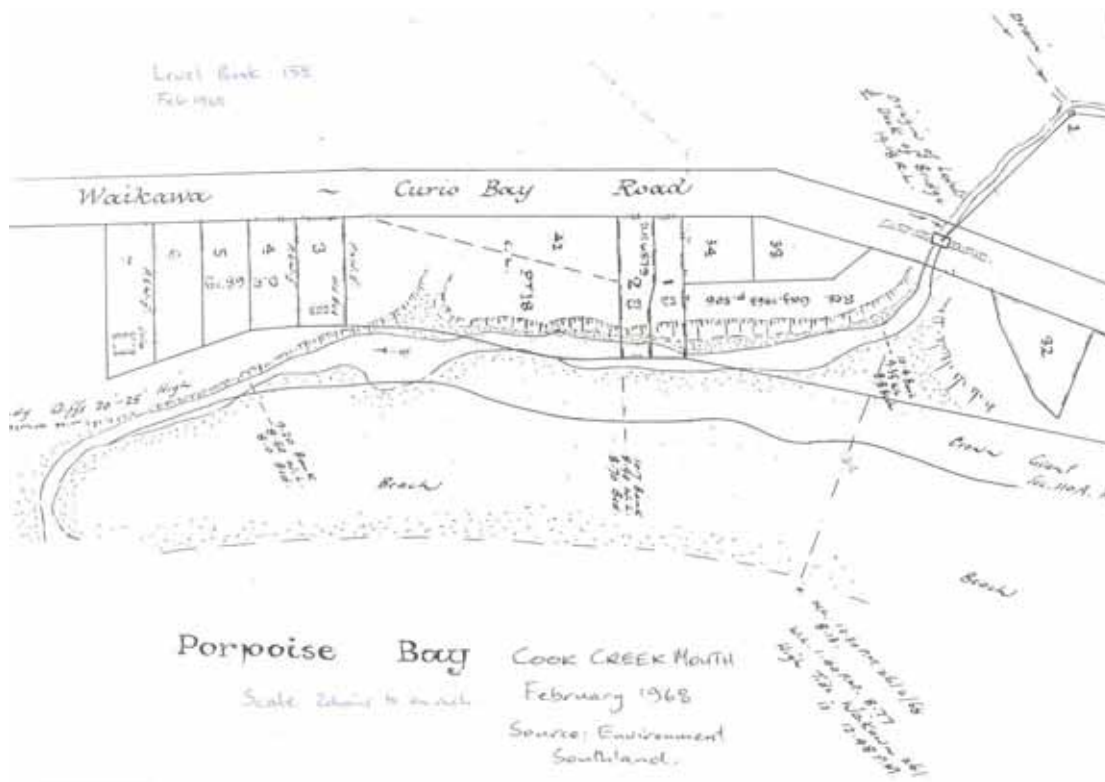


Figure 20 Cook Creek Mouth, Feb 1968



Fig 20a Cook Creek Mouth, January 2008.



Figure 21 SO 461 - Original Survey of Waikawa (1864). Note: Antrim St surveyed across the foreshore.

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